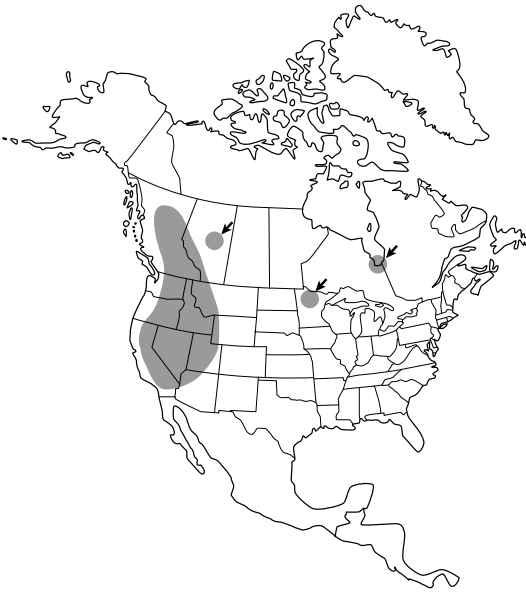


## ***Botrychium lunaria* var. *crenulatum***

<b>Family:</b>	Ophioglossaceae
<b>Genus:</b>	<i>Botrychium</i>
<b>Species:</b>	<i>Botrychium lunaria</i> var. <i>crenulatum</i> (W. H. Wagner) Stensvold comb. nov. ined.
<b>Common names:</b>	Dainty moonwort, Crenulate moonwort
<b>Ploidy:</b>	Diploid



**Technical description.**—Leaf 10 (6-16) cm tall, texture herbaceous, color (living and freshly pressed) yellowish green; common stalk 0.60 (0.50-0.80) of the total leaf length; sterile segment stalk 5 (1-17) mm long, the blade (pressed) ovate-oblong to linear-oblong, 2 (0.5-6.5) cm long, 1.2 (0.8-1.8) cm wide; segments 3 (2-5) pairs, wedge-shaped, the lower and upper margins of the medial pinnae an angle of  $70^\circ$  ( $20^\circ$ - $110^\circ$ ), their outer edges separated by 80 (30-120)% of the width of the pinnae, often narrowly cuneate toward the base, the largest pinnae 6 (3-12) mm wide, with 15 (10-25) veins reaching the distal margin; margins crenulate (entire to crenate or dentate), and in very large specimens sometimes with 1-5 incisions  $1/5$  (up to  $1/2$ ) of the pinna length; fertile segment 4.5 (2.5-9.5) cm tall, the sporangial branches confined mainly to the upper  $1/2$  ( $1/3$  -  $2/3$ ), without major proximal sporangial branches; spores 45 (40-48) micrometers in diameter; chromosomes  $2n = 90$  (Wagner and Wagner, 1981).

## Taxonomy

*Botrychium lunaria* var. *crenulatum* was described as a new species in 1981 based on specimens from the San Gabriel, San Bernadino and Southern Sierra Mountains of southern California (Wagner and Wagner, American Fern Journal 71:20-30). Photographs and silhouettes of the species are included in that publication.

## Identification

*Botrychium lunaria* var. *crenulatum* is one of few moonworts in which the span of the basal pinnae often approaches a half circle (pinna span  $> 150^\circ$ ). In the range of *B. lunaria* var. *crenulatum*, only *B. neolunaria*, *B. tunux* and *B. yaaxudakeit* regularly reach or exceed this span. *Botrychium lunaria* var. *crenulatum* can be differentiated from these species by its more delicate texture, light green color, and finely crenulate pinna margins. It typically has fewer pinna pairs than *B. neolunaria* (2-5 vs 3-7), a more distinctly stalked trophophore, and a sporophore stalk, at spore release, approximately equal to the length of the trophophore (stalks of *B. neolunaria* and *B. yaaxudakeit* are usually longer). The lower sporophore branches of *B. lunaria* var. *crenulatum*, unlike those of *B. neolunaria* and *B. yaaxudakeit*, tend to be twisted so that the sporangia project downward or outward (as they also do in *B. tunux* and European *B. lunaria* var. *lunaria*). Plants of *B. lunaria* var. *crenulatum* with narrower pinnae (commonly the case in sun-grown plants of fen habitats) more closely resemble *B. minganense* and *B. ascendens*. They can be distinguished from plants of those species by their horizontal to only slightly ascending pinnae and by their pinna margins. Pinna of *B. ascendens* and *B. minganense* are distinctly ascending; pinna margins of *B. ascendens* are dentate to cleft and those of *B. minganense* are usually entire to lobed; neither have the fine crenulations nor the delicate texture of *B. lunaria* var. *crenulatum*. *B. lunaria* var. *crenulatum* also differs from *B. ascendens* and *B. minganense* by its diploid chromosome number ( $n = 45$ ).

## Distribution and Abundance

*Botrychium lunaria* var. *crenulatum* has been reported from most western states, ranging from Colorado, Arizona, Utah, Nevada and California to British Columbia, Alberta, the James Bay region of Ontario and northern Minnesota. Throughout its range this species is less common than most moonworts. Its presence in boreal vegetation in central Alberta and Minnesota suggests that populations of *B. lunaria* var. *crenulatum* may exist or have existed farther east in boreal Canada and eastern US.

In California *B. lunaria* var. *crenulatum* has much the same distribution as *B. simplex* and is the second most widespread species. However, it is seldom abundant and is usually limited to small extents of habitat, often seep and spring habitats also supporting *B. simplex* var. *simplex*. *B. lunaria* var. *crenulatum* is apparently more tolerant of water chemistry than is var. *simplex*, requiring only a saturated, non-acidic substrate. Its California occurrences are scattered from San Bernadino to Modoc Counties and westward to Colusa County. More occurrences of *B. lunaria* var. *crenulatum* can likely be found with intensive search for occurrences of its habitat, particularly in fen-seeps in southern California.

## Habitat

*Botrychium lunaria* var. *crenulatum* is one of the most hydrophyllic of *Botrychiums*. It usually grows in saturated soils of seeps and along the stabilized margins of small streams, often among dense herbaceous vegetation. It also occurs occasionally in seasonally wet roadside ditches and drainageways. In these habitats it is usually found in partly shaded to heavily shaded sites at mid to high elevations. In drier areas of the southwestern US it is often found in hardwater fens where it may grow in open sun.

## Genetics

The genetics of *Botrychium lunaria* var. *crenulatum* has been studied in populations in Washington, Montana, Oregon, California, Nevada, Utah and Colorado. Among these populations there is very little genetic variation. Lack of allelic variation precludes direct detection of the breeding system of *B. lunaria* var. *crenulatum*, but it likely reproduces as do most other members of the genus, by intragametophytic selfing. A lack of among-population variation may indicate a recent (post-Pleistocene) attainment of its current distribution and possibly a continuing dispersal between sites.

## Phylogenetic Relationships

Among other diploid moonwort species, *B. lunaria* var. *crenulatum* is morphologically and genetically most closely related to European *B. lunaria* var. *lunaria*. This relationship is so close that Stensvold (2008) has concluded that *B. lunaria* var. *crenulatum* is best treated as a variety of *B. lunaria*. It is quite distinct genetically, however, from American *B. neolunaria*, as concluded by W. H. Wagner in describing the taxon as a distinct species.

*B. lunaria* var. *crenulatum* is a probable ancestral parent to one allotetraploid species. It has combined with a member of the *B. campestre*

complex (see discussion of *B. campestre* var. *lineare*) to produce *B. ascendens*. *B. ascendens* displays toothed to lobed pinna margins reflecting its *B. lunaria* var. *crenulatum* heritage.

Additional photographs of *Botrychium lunaria* var. *crenulatum*

